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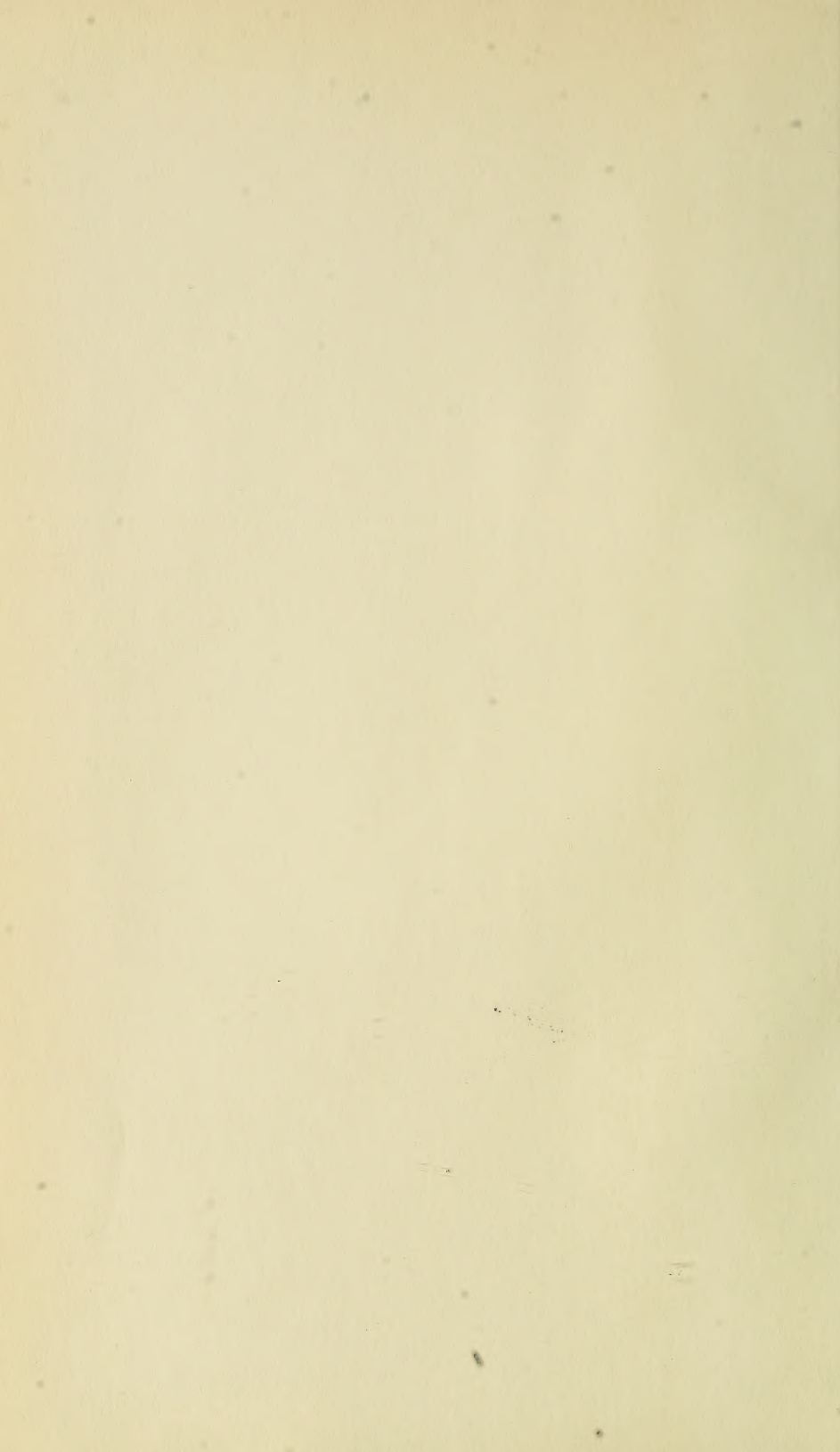


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24

Bulletin 99

PALEONTOLOGY 15

GEOLOGIC MAP

OF THE

BUFFALO QUADRANGLE

BY

D. D. LUTHER

BUREAU OF
AMERICAN ETHNOLOGY.
1906
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New York State Education Department
Science Division, May 17, 1905

Hon. Andrew S. Draper
Commissioner of Education

MY DEAR SIR: I take pleasure in communicating herewith for publication as a bulletin of the State Museum a *Geologic Map of the Buffalo Quadrangle*, prepared on the scale of 1 mile to the inch and including the region about the city of Buffalo.

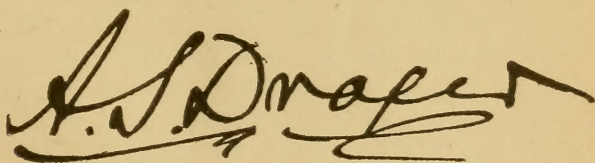
In view of the zeal with which geologic science is studied in this important center of population I am convinced that the map and the accompanying explanation thereof will appeal to a large element of our people.

Very respectfully yours

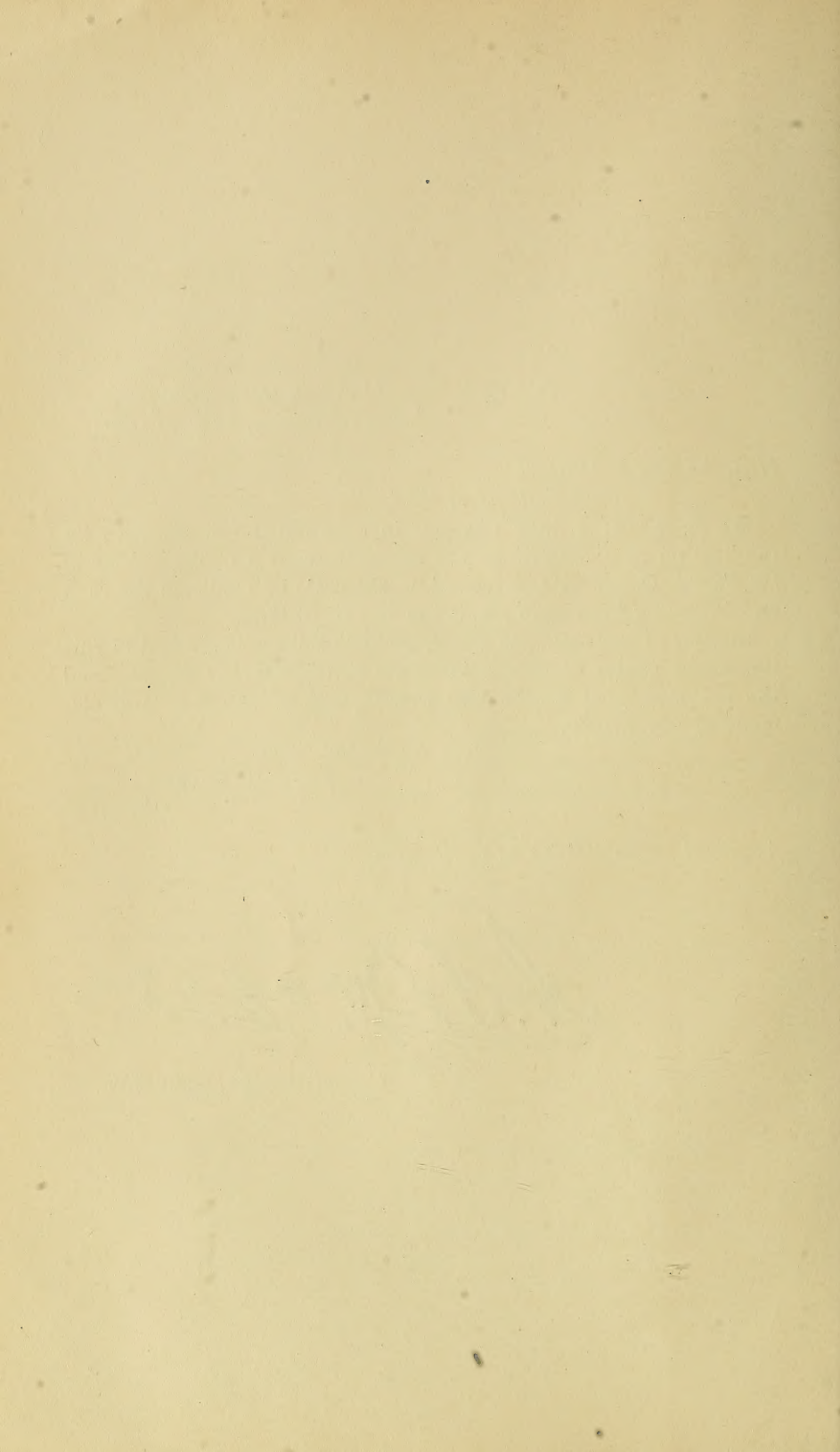
JOHN M. CLARKE

Director

Approved for publication May 18, 1905

A large, stylized handwritten signature in dark ink, reading 'A. S. Draper'. The signature is written in a cursive style with a prominent initial 'A' and a long, sweeping underline.

Commissioner of Education.



New York State Education Department

New York State Museum

JOHN M. CLARKE Director

Bulletin 99

PALEONTOLOGY 15

GEOLOGIC MAP

OF THE

BUFFALO QUADRANGLE

BY

D. D. LUTHER

PREFACE

The map herewith presented affords accurate data in regard to the surface rocks and succession of strata at and in the immediate neighborhood of the second city of the State in size and importance; over an area where the rocks yield and are eagerly exploited for natural gas, natural cement and other industrial products. Students of geology in Buffalo will find the map and its accompanying text a detailed guide to the rock sections of the region and to the scattered and often obscure outcrops of the formations.

The Buffalo quadrangle embraces geologic formations which extend from the Upper Siluric well into the Upper Devonian. The tracing of the boundaries of these formations here has been beset with special difficulties arising from the essentially level character of most of the region, the absence of creeks flowing across the strike of the beds over much of the area and the presence of an all obscuring mantle of glacial drift. The boundaries are therefore to some degree constructional, but are believed to be as nearly correct as can now be determined from data of every kind.

In approaching this region from the east the Helderberg escarpment traversing the State as a notable topographic feature here becomes lessened and flattened out; again, the northern edge of the Appalachian plateau which enters the southern part of the

quadrangle from the east is less pronounced than in the central part of the State. Both of these facts have led to the obscuration of the stratigraphy of the region.

The rocks of Buffalo abound in fossils often of the most interesting character. These have been cited here under their respective formation names, but for fuller accounts of the species with analytic illustrations the student must refer to the volumes of the *Palaeontology of New York*.

In the preparation of this map the territory has been carefully resurveyed by D. Dana Luther, field assistant on the geologist's staff. In this work he has had the assistance of Prof. Irving P. Bishop of Buffalo, who several years ago at the solicitation of the State Paleontologist prepared a map of the quadrangle giving the boundary lines of the formations with their broader and earlier value. Much previous work has been done in the same field. Professor Bishop prepared and published in the 15th Annual Report of the State Geologist a special account with a map of the structural and economic geology of Erie county, at a date when a detailed topographic map was not available. In 1901 Prof. A. W. Grabau prepared and published a map and descriptive account of the northern part of this region in State Museum bulletin 45, *A Guide to the Geology and Paleontology of Niagara Falls and Vicinity*, but it has been possible since then to trace the stratigraphic boundaries in much more refinement of detail. The reader may find it desirable to refer to both of these publications; the latter especially for a summary account of the fossils in the northern formations of the region. Professor Grabau has also published in the 16th Annual Report of the State Geologist and as a bulletin of the Buffalo Society of Natural Sciences, volume 6, a full descriptive account of the formations and fossils in the rocks exposed at Eighteen Mile creek, and Professor Bishop has supplemented his original report on Erie county with more recent notes on the gas wells and production of the region, in the 17th and 19th reports of the State Geologist.

JOHN M. CLARKE
State Geologist

GEOLOGY OF THE BUFFALO QUADRANGLE

The strata composing the surface rocks of this quadrangle as delineated on the map have an aggregate thickness of 804 feet, of which 310 feet are exposed by the difference of elevation between the lowest horizon, 570 feet above tide, where the north line of the quadrangle crosses Niagara river, and the highest land 880 feet above tide in the southeast corner near Orchard Park; 494 feet of this thickness are brought up by the northeastern elevation of the beds which thus show the average dip to be 28 feet a mile.

This dip, however, is variable as the strata roll in broad undulations, and it is also modified by changes in the thickness of the different formations throughout their extent. In the vicinity of Black Rock the dip is about 40 feet a mile toward the south, while in the southern part of the quadrangle it decreases to 25 feet.

In a well put down by the Lackawanna Steel Co. in 1904 on the bank of Smoke's creek in West Seneca, the bottom of the Onondaga limestone was found at the depth of 292 feet or 288 feet above tide, and that horizon appears in the quarry of the Buffalo Cement Co., 10½ miles north of the well at 640 feet above tide, showing a southward dip of 352 feet or an average of nearly 34 feet a mile.

SUCCESSION OF STRATA

The following formations are represented on this quadrangle:

Devonic	Neodevonic	Senecan	Portage	{	Rhinestreet black shale
					Cashaqua gray shale
	Mesodevonic	Erian	Genesee	{	West River shale
					Genundewah limestone
					Genesee black shale
Siluric	Paleo-devonic	Ulsterian	Hamilton	{	Moscow shale
					Tichenor limestone
					Ludlowville shale
	Paleo-devonic	Oriskanian	Marcellus	{	Skaneateles shale
					Cardiff shale
Siluric	Cayugan	Oriskany	Onondaga	{	Stafford limestone
					Marcellus black shale
					Onondaga limestone
Siluric	Cayugan	Oriskany	Oriskany	{	Onondaga limestone
					Oriskany sandstone
					Oriskany sandstone
Siluric	Cayugan	Salina	Salina	{	Cobleskill waterlime
					Bertie waterlime
					Camillus shale

UPPER SILURIC

Salina beds

Camillus shale

The lowest formation exposed within the limits of the quadrangle is the Camillus shale, which is the surface rock over an area of 35 square miles north of Buffalo and Williamsville.

It is entirely covered by drift on the American side of Niagara river excepting a small outcrop at the extreme south end of Grand island. On the Canadian side the upper beds are exposed in the low cliffs along the river from a point opposite Strawberry island almost to the International bridge.

The rock at these exposures is mostly soft, light gray or olive gypseous shale; a few thin layers are harder and more blocky in structure.

About 75 feet of Camillus shale come to the rock surface on this quadrangle but these do not represent the entire formation. Its precise thickness here is not known, but well cores show that beds of gypsum, thinner and less pure toward the bottom, occur at intervals through 150 feet or more of strata.

The Vernon red shales that underlie the Camillus shale in the central part of the State have not been recognized in the deep borings about Buffalo, and if the Camillus formation is to here include all of the strata between the Guelph dolomite of the Niagaran group beneath, and the Bertie waterlime above, its average thickness as shown in 10 wells is 333 feet.

Gypsum and plaster have been mined in the Camillus shale in Genesee, Monroe, Ontario, Seneca, Cayuga and Onondaga counties in very large quantities but thus far no fossils have been found in these beds in the western part of the State. The little brackish water crustacean *Leperditia alta* occurs below the upper gypsum bed in Onondaga county.

Bertie waterlime

The passage from the Camillus shale to the succeeding formation is a gradual one, the gypsum slowly diminishing in quantity and the rock becoming much harder and, by the addition of alumina and carbonate of magnesia, highly dolomitic. The Bertie waterlime is usually in layers from a few inches to 2 to 3 feet thick, separated by thin seams of carbonaceous matter. Though very dark when fresh the rock weathers to a light brown or buff.

The proportion of calcareous matter varies considerably in the different layers, the composition of many of them being such as to make true hydraulic limestone or "cement rock." A bed of this

character, 5 to 6 feet thick, at the top of the formation has been extensively quarried in Buffalo by the Buffalo Cement Co. and also at Williamsville for the production of natural cement. The cement produced at Akron, 12 miles east of the quadrangle, is also from the same stratum.

At the quarry of the Buffalo Cement Co. the Bertie waterlime is 53 feet thick, as shown by the core of a well drilled in 1883, now in the museum of the Buffalo Society of Natural Sciences.

This rock is exposed along the west side of Niagara river, between the International bridge and the stone church; in the bed of Scajaquada creek in Forest Lawn cemetery; very abundantly in the Buffalo Cement Co.'s quarries and at Williamsville, on this quadrangle; also at Falkirk, Indian Falls, Morganville, North Leroy, Garbuttville, Honeoye Falls, East Victor, Phelps and other places to the east of this quadrangle; and toward the west at Bertie Ont., whence the name of the formation is derived.

This formation is characterized by an abundant and peculiar crustacean fauna; in fact it has long been famous for its strange lobsterlike fossils belonging to the extinct orders, Eurypterida and Phyllocarida and the cement quarries of Buffalo have proved veritable treasure chambers of these odd creatures. The following species have been observed in the vicinity of Buffalo.

The ostracod, *Leperditia scalaris* Jones, occurs abundantly in the lower part of the formation as exposed along Scajaquada creek in Forest Lawn cemetery.

The cement layer has furnished the following species of fossils:

<i>Ceratiocaris acuminata</i> Hall	<i>E. scorpionis</i> Grote & Pitt
<i>o. grandis</i> Pohlman)	<i>Pterygotus acuticaudatus</i> Pohlman
<i>Eurypterus lacustris</i> Hall	<i>P. bilobus</i> Huxley & Salter
<i>E. remipes</i> De Kay	<i>P. buffaloensis</i> Pohlman
<i>E. giganteus</i> Pohlman	<i>P. cummingsi</i> Pohlman
<i>E. pustulosus</i> Hall	<i>P. macrophthalmus</i> Hall
<i>E. robustus</i> Hall	<i>P. quadraticaudatus</i> Pohlman
<i>E. pachychirus</i> Hall	<i>P. globicaudatus</i> Pohlman
<i>E. dekayi</i> Hall	<i>P. cobbi</i> Hall
<i>Dolichopterus macrochirus</i> Hall	<i>Leperditia scalaris</i> Jones
<i>Eusarcus grandis</i> Grote & Pitt	

Besides these crustaceans some brachiopods belonging to the genera *Orbiculoidea* and *Lingula* and some seaweeds have been found; among these *Bythotrephes lesquereuxi* Grote and Pitt.

Cobleskill waterlime

The bed which overlies the Bertie waterlime has lately been properly correlated by Hartnagel¹ with the Cobleskill limestone (formerly Coralline limestone) of eastern New York. Previously it

¹State Paleontol. An. Rep't 1902. N. Y. State Mus. Bul. 69. 1903.

was referred by Bishop to the "Onondaga limestone" (in distinction from the Corniferous limestone, which in this paper is termed Onondaga limestone) and to the Manlius limestone by Clarke¹ and Grabau.²

The Cobleskill waterlime immediately overlies the cement layer, the transition being gradual through 2 or 3 feet of strata, above which the rock is a dark subcrystalline dolomitic limestone in uneven layers, usually but a few inches thick, separated by thin seams of carbonaceous matter. It sometimes has a brecciated appearance and after exposure is usually more or less porous, owing to the dissolving out of calcite crystals and of a small coral *Cyathophyllum hydraulicum*, which is very common throughout and specially so in the upper part. Though very dark colored when fresh, the rock becomes buff or light brown when exposed and it is locally known to quarrymen as "bullhead" or "pumpkin head."

The formation is 7 to 9 feet in thickness on this quadrangle, the variation being due to erosion of the upper surface and not to irregularity of deposition which the evenness of the bedding planes shows to have taken place in quiet waters.

At Falkirk, Erie co. this formation attains a thickness of 14 feet, but it becomes thinner again toward the east as far as Livingston county; then it increases slowly to 10 feet in Herkimer county, again diminishing to 6 to 8 feet in the Hudson valley. The rock is fairly fossiliferous, the most abundant form being the small coral *Cyathophyllum hydraulicum* Simpson.

Besides this are found in Erie county:

<i>Nematophyllum crassum</i> Penhallow	<i>W. nucleolata</i> Hall var.
<i>Favosites</i> sp.	<i>W. cf. laevis</i> Whitfield
<i>Orthothetes interstriatus</i> Hall (=O.	<i>Rhynchonella</i> sp.
<i>hydraulicus</i> Whitfield)	<i>Loxonema</i> ?
<i>Spirifer eriensis</i> Grabau	<i>Pleurotomaria</i> ?
<i>Whitfieldella sulcata</i> Vanuxem	<i>Trochoceras gebhardi</i> Hall

There are good exposures of this formation on Scajaquada creek in Forest Lawn cemetery; in the Buffalo Cement Co.'s quarries; in Miller's quarry and at Williamsville on this quadrangle, and at Akron, Falkirk, Indian Falls, Morganville, North Leroy, East Victor, Union Springs, DeWitt, Cobleskill, Rondout and many other places in the central and eastern parts of the State.

¹N. Y. State Mus. Mem. 3. 1900.

²Geol. Soc. Am. Bul. 1900. v. 11.

DEVONIC

The division line between the great Siluric and Devonic systems is well marked here on account of the entire absence of Helderbergian limestones, which in the eastern part of the State represent the earlier stages of Devonian deposition.

Its peculiarities in this area have been fully noted by Clarke,¹ Grabau,² and Hartnagel³ and are briefly stated below.

Oriskany sandstone horizon

The Cobleskill waterlime is the highest Siluric formation represented on the Buffalo quadrangle. The Paleodevonic strata rest unconformably on it, the Rondout waterlime and the Manlius limestone not extending into the western part of the State. The surface of the Cobleskill gives unmistakable evidence of having suffered considerable erosion in the long period during which those formations were being deposited. The most important facts indicating this interval of erosion are the following:

In the Buffalo Cement Co.'s quarries well defined channels and irregular depressions make the surface of the stratum exceedingly rough and hummocky and its line of contact with the superjacent formation as seen in the quarry walls very uneven.

In the bottom of some of these depressions there appear thin masses of dark shale and a conglomerate composed principally of small waterworn fragments of waterlime in a matrix of indurated quartz sand. Because of the extremely slender representation of this formation it is not introduced on the map.

In the quarry wall there are two fissures that extend from the top of the Cobleskill to the bottom of the cement layer. They have been filled with this quartz sand and are covered by a few inches of the conglomerate. This filling of the fissures has been considered as Oriskany sediment by Clarke¹, and the erosion interval as comprising the Helderbergian and part of Oriskanian ages.

At Falkirk, Erie co., and Indian Falls, Genesee co., the character of the deposits in the horizon of this erosion interval is still similar to those on this quadrangle, but farther east the broad lentils of characteristic Oriskany sandstone appear in it.

At Morganville the sandstone is 4 feet thick; in the salt shaft at Livonia, 4 feet, 6 inches; at Honeoye Falls, 1 foot, 2 inches; at North Leroy and Victor only the conglomerate is present; at

¹N. Y. State Mus. Mem. 3. 1900. p.96-98.

²Geol. Soc. Am. Bul. 1900. v.ii. p.357-61.

³State Paleontol. An. Rep't 1902. N. Y. State Mus. Bul. 69. 1903. p.1138.

Phelps, 4 feet, 2 inches of sandstone. In the central and eastern part of the State this formation is an interrupted deposit having at some exposures the character of an arenaceous limestone 1 to 3 feet thick while at Union Springs, Onondaga Valley, Oriskany Falls and other localities it is a friable, light colored and rather coarse sandstone containing an abundance of fossils. It attains a thickness of more than 20 feet in a lentil in the northeast corner of the town of Skaneateles, Onondaga co.¹

Onondaga limestone

This important deposit is a compact, dark bluish gray limestone bedded in layers from 3 inches to 2 feet thick and carrying interbedded nodules and nodular layers of chert.

The limestone contains a large amount of carbonaceous matter, which appears in the shaly partings and on the surface of the layers discoloring and giving them a black appearance. This carbonaceous admixture is removed by slow decomposition on exposure and the rock then assumes a very light bluish gray color.

The chert, as a rule, is nearly black and slightly translucent, but sometimes lighter colored and bluish. It is very unevenly distributed in the beds; in some it largely predominates and in others it is entirely absent. It forms nodular layers which are frequently continuous for long distances. Outcrops of these and boulders of the cherty limestone that have been long exposed present a peculiarly ragged and scraggly appearance, owing to the superior resistance to decomposing agencies that the chert possesses over the limestone.

At some outcrops a very small portion of the formation is shaly, but all of the remainder wherever the amount of chert is not too large, is somewhat compact and durable and exceedingly valuable as building stone and for the production of quicklime.

At the base of the formation, filling the depressions in the Cobleskill waterlime and varying greatly in thickness, there occurs a stratum of limestone almost entirely free of chert, and embracing lenses of considerable extent wholly composed of corals.

The latter stratum is but 5 inches thick in the bed of Scajagada creek at the Main street bridge; 7 feet in an old quarry in Forest Lawn cemetery; 5 feet, 6 inches in the park quarry; 5 feet in the southern part of the Buffalo Cement Co.'s quarry and less than 2 feet in the northern. It is a veritable coral reef, 35 feet

¹These lentils of sandstone in the strike of the Oriskany formation have been described by Clarke. Amer. Ass'n: Adv. Sci. Proc. 1900; Science. Dec. 28, 1900.

thick in Fogelsonger's quarry at Williamsville and in Quinn's quarry 2 miles farther east, but decreases rapidly to 3 feet a short distance beyond. The bed is recognizable continuously toward the east along the Helderberg escarpment to Albany county, varying in thickness but maintaining the same general character, and is quarried all along this line of outcrop, furnishing a large amount of building and dimension stone of fine quality.

The succeeding beds, which contain a large proportion of chert, are also quarried extensively, furnishing excellent material for road making and concrete. Some layers in the upper beds are again almost free from chert at certain localities.

The lower Onondaga limestone beds are well exposed on the west side of Niagara river at Black Rock and slightly on its east side; also in Forest Lawn cemetery; also extensively in the Buffalo Cement Co.'s quarries and thence northeastward to Fogelsonger's quarry and Williamsville. Larger exposures of the middle and upper part of the formation may be seen in quarries in the region extending on both sides of Fillmore avenue from Leroy avenue to Delevan and from Leroy avenue to Worcester place and along Delevan avenue to Dutton; also in Cutter & Bailey's quarry at the intersection of Bailey avenue and the New York Central Railroad.

Beyond the limits of this quadrangle extensive exposures embracing the entire section of this formation are found in the vicinity of Leroy, Genesee co.; Phelps, Ontario co.; Union Springs, Cayuga co. Marcellus, Onondaga Valley, Jamesville and Manlius, Onondaga co. and at other localities still farther east in the State.

The average thickness of the Onondaga limestone in 12 wells in this vicinity according to driller's records is 168 feet. In the carefully kept record of the Lackawanna Steel Co.'s well on Smoke's creek 1904, it is given as 162 feet. It is somewhat less in the eastern part of the quadrangle. At the Livonia salt shaft in Livingston county it is 136 feet; in the deep well at Ithaca, 78 feet; in Onondaga county, 65 feet; at Clarksville, Albany co., 85 feet and at Countryman hill, 100 feet.

This formation is exceedingly rich in remains of animal life but it is frequently quite difficult to obtain good specimens. There have been found in it 3 species of fish; 39 of crustaceans, mostly trilobites; 13 of cephalopods; 3 of pteropods; 38 of gastropods; 15 of lamellibranchs; 48 of brachiopods; many bryozoans and corals and a few crinoids. Some of the more common fossils are: the trilobites *Odontocephalus selenurus* and *Pha-*

cops cristata var. pipa; the cephalopods, *Cyrtoceras undulatum* and *Gyroceras trivolve*, and the brachiopods, *Atrypa reticularis*, *Leptaena rhomboidalis*, *Stropheodonta concava*, *S. inaequistriata*, *Spirifer acuminatus* and *S. divaricatus* and others.

Marcellus beds

Marcellus black shale

The term Marcellus shale has been generally applied in New York geology to the series of black and dark blue shales which lie immediately on the Onondaga limestone and at the top pass gradually into the lighter colored Hamilton shales. At Marcellus, Onondaga co., from which place the name is derived, only the lower layers are well exposed and observations in that region and in the western part of the State indicate the desirability of restricting the term to the lower shales, exposed at the type locality, thereby obtaining a more exact basis for correlation.¹

From Ontario county westward the thin Marcellus black shale is delimited upward by the Stafford limestone. The rock is a densely black and highly bituminous slaty shale with a few thin calcareous layers and rows of spherical concretions.

Neither the lower nor upper contacts with the limestones are exposed on this quadrangle, and the shales nowhere come to the surface. The thickness of the formation can therefore only be estimated or obtained from well records.

The beds are 41 feet thick in the Livonia salt shaft and contain a 5 foot stratum of soft limestone, 27 feet below the top. The most western exposure of the Marcellus shale is in the bed of Plumbottom creek at Lancaster, 6 miles east of the east line of this quadrangle. A layer of limestone 1 foot thick forming there the bottom of the outcrop and separated by 18 to 20 feet of black shale from the Stafford limestone probably represents the five foot stratum of the Livonia salt shaft. Since the contact with the Onondaga limestone is not exposed at this locality it fails to furnish information on the entire thickness of the Marcellus shale. This has been obtained in the well on Smoke's creek, previously mentioned, where a total thickness of 55 feet has been measured.

The fauna of the black shales is small and fossils are rare except

¹N. Y. State Mus. Bul. 63, p. 14.

at the base of the formation. The limestones are, on the contrary, highly fossiliferous and often entirely composed of shells. The fauna of the Marcellus shales and limestones of Lancaster has been thoroughly studied by Wood,¹ who records as the most common forms of the shale *Styliolina fissurella* Hall, *Chonetes mucronatus* Hall, *Strophalosia truncata* Hall, *Pterochaenia fragilis* Hall and *Liorhynchus limitare* Vanuxem. The lowest shale exposed proved to contain abundant ostracod valves, belonging to the species *Isochilina* (?) *fabacea* Jones and *Primitiopsis punctulifera* Hall.

Stafford limestone

On Flint creek in the town of Phelps, Ontario co., the Marcellus shales are capped by a 4 inch layer of dark chocolate limestone which is very hard when fresh but breaks easily into angular fragments after exposure. It is not known farther east but increases westward from 2 feet or more at the Livonia salt shaft to nearly 4 feet at Stafford, where it is well exposed and whence the name is derived, and to 8 feet, 4 inches at Lancaster, Erie co. The record of the Smoke's creek well makes it even 15 feet thick at that point. There are no exposures of the entire formation on this quadrangle but the upper layers outcrop to the thickness of nearly 6 feet in the bed of Buffalo creek opposite the end of the Winchester road, $\frac{3}{4}$ mile east of South Buffalo and $1\frac{1}{2}$ miles south of the junction with Cayuga creek, at which latter point there is a small exposure of Onondaga limestone.

The Stafford limestone is here a compact bluish gray limestone, mostly in thick layers and bearing a strong resemblance to the Onondaga limestone by the admixture in considerable proportion of dark chert in nodules and nodular layers. It has been found in excavations at several places southwest from this exposure but nowhere comes to the surface and its precise position on the lake shore is not known, the bed being completely buried under heavy drift cover.

Besides the exposures previously mentioned it appears in the east bank of the Oatka river at Leroy and along the outlet of Conesus lake at Littleville near Avon.

Fossils are abundant in the Stafford limestone at Lancaster, specially in the upper part and some layers are entirely made up of

¹N. Y. State Mus. Bul. 49. 1901, p. 139-81.

shells of *Strophalosia truncata* and *Ambocoelia nana*. Miss Wood records a total of 72 species. The more common and characteristic of these are:

<i>Ambocoelia nana</i> <i>Grabau</i>	<i>Spirifer</i> (Martinia) <i>subumbonus</i> <i>Hall</i>
<i>Chonetes mucronatus</i> <i>Hall</i>	<i>Cypricardinia indenta</i> (<i>Conrad</i>)
<i>C. scitulus</i> <i>Hall</i>	<i>Orthoceras exile</i> <i>Hall</i>
<i>Liorhynchus limitare</i> (<i>Vanuxem</i>)	<i>O. marcellense</i> <i>Vanuxem</i>
<i>Strophalosia truncata</i> (<i>Hall</i>)	<i>Phacops rana</i> (<i>Green</i>)
<i>Meristella barrisi</i> <i>Hall</i>	<i>Primitiopsis punctulifera</i> <i>Hall</i>

Cardiff shale

The upper beds usually included in the old term Marcellus, and designated by Vanuxem the "Upper shales of Marcellus" are abundantly exposed about the village of Cardiff, Onondaga co., and recently have been named from that locality.¹

This division consists of a series of dark calcareous and black slaty shales with thin layers of fossiliferous limestone. Rows of spheric concretions occur in the lower part at some localities. The fossil contents are not essentially different from those below the Stafford limestone, but the shales are more calcareous and weather, specially in the upper beds, to an ashen gray.

The beds immediately above the Stafford limestone are not exposed on this quadrangle but an exposure beginning near the New York Central Railroad bridge over Buffalo creek, $\frac{1}{4}$ mile west of the outcrop of Stafford limestone previously mentioned and not more than 15 feet above it, extends along the bed of the stream to Gardenville and the east line of the quadrangle. The lower shales outcrop on Cazenovia creek at the park just above Cazenovia street, and the upper beds at the covered bridge, nearly 2 miles farther up the creek.

At West Seneca outcrops occur in the line of Smoke's creek between White's Corners and the western New York and Pennsylvania Railroad and at the north end of the low cliff on the lake shore at Bay View.

The more important exposures of the Cardiff shales toward the east are along Plumbottom creek at Lancaster; along Oatka river at Leroy; Conesus outlet at Littleville near Avon; Flint creek near Orleans, Ontario co. and in the vicinity of Marcellus and Cardiff in Onondaga county.

The thickness of the Cardiff shales on this quadrangle is estimated to be 45 feet. In Ontario county it is 100 feet and at Cardiff, Onondaga co. 175 feet.

¹N. Y. State Mus. Bul. 63. 1903. p. 16.

In the exposure of the lower and more calcareous beds of the Cardiff shales, immediately overlying the Stafford limestone at Lancaster the following species of fossils were found by Wood:

<i>Ceratopora dichotoma</i> <i>Grabau</i>	<i>Meristella barrisi</i> <i>Hall</i>
<i>Chonetes lepidus</i> <i>Hall</i>	<i>Pterochaenia fragilis</i> (<i>Hall</i>)
<i>Liorhynchus limitare</i> (<i>Vanuxem</i>)	<i>Styliolina fissurella</i> (<i>Hall</i>)
<i>Atrypa reticularis</i> (<i>Linné</i>)	<i>Orthoceras aegea</i> <i>Hall</i>
<i>Ambocoelia umbonata</i> (<i>Conrad</i>)	<i>Phacops rana</i> (<i>Green</i>)

Tornoceras uniangulare and *Orbiculoidea minuta* are common fossils in this horizon in Livingston and Ontario counties.

Hamilton beds

Skaneateles shale

This term was applied by Vanuxem to the beds immediately overlying the upper Marcellus (Cardiff) shale and exposed on both sides of the north end of Skaneateles lake. It subsequently fell into disuse when the term Hamilton group, employed by Vanuxem for certain beds of shales at West Hamilton, Madison co. had been extended to all the formations lying between the Onondaga and Tully limestones. When recently the State survey found itself compelled to adopt more exact and refined classification of the strata than that hitherto in use, the term Skaneateles shale was reapplied in its original meaning and scope. The Skaneateles shale is the lowest division of the Hamilton beds.

At the base the shales are hard, dark bluish or black and calcareous, passing into somewhat lighter and softer beds above, and containing several rows of small concretions. On the lake shore south of Bay View the division is 40 feet thick. It increases toward the east and has a thickness of 125 feet in Ontario county and of 335 feet in the Onondaga valley in Onondaga county.

The entire section of the Skaneateles shale is exposed in the cliff along the lake shore between the Bay View and Athol roads and along the south branch of Smoke's creek, 1 mile east of Blasdell. The Skaneateles shale also outcrops along the north branch of Smoke's creek $\frac{1}{2}$ mile west of Reserve and along Cazenovia creek $\frac{1}{2}$ mile east of Reserve.

At Blossom, 3 miles beyond the eastern boundary of this quadrangle, a bed of hard limestone 4 feet thick at or near the base of the Skaneateles shale contains many cyathophylloid corals and other fossils. The bed becomes softer toward the west and the corals disappear. It is a shaly limestone where it outcrops on the

south branch of Smoke's creek a mile below Windom, and a 2 foot band of calcareous shale in the cliff at Bay View.

Outside of this quadrangle the Skaneateles shale is exposed in the bed of Mud creek below Wheeler in Ontario county; in Great gully, 3 miles south of Union Springs, Cayuga county, and in the Bear mountain ravine near Tully valley in Onondaga county.

Fossils are rare except in the lower calcareous shale. The following is a list of fossils reported as obtained from these shales by A. W. Grabau:

Phacops rana (<i>Green</i>)	Chonetes mucronatus <i>Hall</i>
yphaeus boothi (<i>Green</i>)	C. setigerus <i>Hall</i>
Primitiopsis punctilifera (<i>Hall</i>)	C. scitulus <i>Hall</i>
Orthoceras <i>sp.</i>	C. lepidus <i>Hall</i>
Tentaculites gracilistriatus <i>Hall</i>	Productella spinulicosta <i>Hall</i>
Styliolina fissurella (<i>Hall</i>)	Strophalosia truncata <i>Hall</i>
Euomphalus (Phanerotinus) laxus <i>Hall</i>	Spirifer mucronatus (<i>Conrad</i>)
Bellerophon leda <i>Hall</i>	Ambocoelia umbonata (<i>Conrad</i>)
Pterochaenia fragilis (<i>Hall</i>)	Liorhynchus limitare (<i>Vanuxem</i>)
Nuculites triqueter <i>Conrad</i>	Tropidoleptus carinatus (<i>Conrad</i>)
Orthothetes arctostriatus <i>Hall</i>	Crinoid stems

Ludlowville shale

This formation embraces that part of the rock section extending from the base of a 6 inch layer of soft limestone capping the Skaneateles shale and containing *Strophalosia truncata* abundantly, to the Tichenor limestone. The term applied to this member of the series is one of the earliest in the New York nomenclature and the occasion of its revival is explained in Museum bulletin 63, p. 17-20, 1904.

The shale is mostly fine, soft and evenly bedded, light to dark bluish gray in color and but slightly calcareous. In the lower part there are several thin layers of limestone and calcareous concretions are common. Next above the *Strophalosia* bed above mentioned, a stratum of concretionary limestone contains *Nautilus magister*; another, 10 feet higher and 3 feet thick, contains many trilobites; and a thinner one, 8 feet below the top of the formation, contains *Athyris spiriferoides* in large numbers.

The calcareous layers at some outcrops consist merely of rows of broad flat concretions and their number and relative positions vary greatly in different exposures; one or another may disappear entirely and a new one come in at a higher or lower horizon.

This formation is 60 feet thick in the southwestern corner of this region and increases toward the east at an average rate of about 1 foot a mile to Ontario county, where it is 125 feet thick. Farther

east it increases more rapidly and attains a thickness of 350 feet in the Tully valley in Onondaga county.

The extreme western exposure of the Ludlowville shale in New York is at the base of the south shore cliffs, which extend for $1\frac{1}{2}$ miles southwest from the mouth of Eighteen Mile creek, $5\frac{1}{2}$ miles beyond the south line of this quadrangle. The lower beds in the cliffs at Idlewild and nearly all of those exposed in Wanakah cliff belong to the Ludlowville shale.

On this quadrangle good exposures may be seen along Avery's creek where the limestones at the base of the formation produce a small cascade just above the lake shore highway bridge; along Rush creek, near Wosgwah station of the Hamburg Electric Railroad; along the south branch of Smoke's creek near Windom; along its east branch, 1 mile southwest from Reserve and along Cazenovia creek, 1 mile east from Reserve.

There are further large exposures of these beds at several localities east of this quadrangle, some of the best being in Ontario county on Shaffer's creek and in the lower part of the ravines on both sides of Canandaigua lake north of Menteth point; on the shore of Cayuga lake between Aurora and King's Ferry from 10 to 16 miles north of Ludlowville; and in Onondaga county, in the Bear mountain and Fellows falls ravines; in the Tully valley and at Pratt's falls in Pompey.

The Ludlowville shales abound in fossils most everywhere. Dr Grabau's list of those obtained from this horizon in the vicinity of Eighteen Mile creek names 120 species, embracing 6 crustaceans, 4 cephalopods, 4 pteropods, 29 lamellibranchs, 50 brachiopods, 1 crinoid, 8 bryozoans and 7 anthozoans.

Some of the more prominent or abundant forms are:

<i>Phacops rana</i> (Green)	<i>Orthothes arctostriatus</i> Hall
<i>Crypheus boothi</i> Green	<i>Chonetes lepidus</i> Hall
<i>Nautilus magister</i> Hall	<i>Chonetes scitulus</i> Hall
<i>Orthoceras nuntium</i> Hall	<i>Spirifer mucronatus</i> (Conrad)
<i>Tentaculites gracilistriatus</i> Hall	<i>Sp. granulosus</i> (Conrad)
<i>Styliolina fissurella</i> (Hall)	<i>Sp. subumbonatus</i> Hall
<i>Platyceras attenuatum</i> Hall	<i>Sp. fimbriatus</i> (Conrad)
<i>Diaphorostoma lineatum</i> (Hall)	<i>Ambocoelia umbonata</i> (Conrad)
<i>Pterinea flabellum</i> (Conrad)	<i>Athyris spiriferoides</i> (Eaton)
<i>Actinopteria decussata</i> Hall	<i>Atrypa aspera</i> (Dalman)
<i>Modiomorpha subalata</i> (Conrad)	<i>Camarotoechia dotis</i> Hall
<i>Paleonilo tenuistriata</i> Hall	<i>Liorhynchus multicostum</i> Hall
<i>Cypriocardina indenta</i> Conrad	<i>Tropidoleptus carinatus</i> (Conrad)
<i>Stropheodonta demissa</i> (Conrad)	<i>Stictopora incisurata</i> Hall
<i>Leptostrophia perplana</i> (Conrad)	<i>Pleurodictyum stylopora</i> (Eaton)
<i>Rhipidomella vanuxemi</i> He?	<i>Streptelasma rectum</i> Hall

Tichenor limestone

This name is applied to a stratum of crinoidal limestone $1\frac{1}{2}$ to 2 feet thick that is persistent toward the east for more than a hundred miles, maintaining the same general character and varying but slightly in thickness. It has been commonly known as the Encrinal limestone, a name applied to it by Hall in 1839. Since the latter term, in the Genesee valley and Canandaigua lake sections, has been applied by others to limestone layers of similar character but occurring at distinctly different horizons, confusion had arisen and a more distinctive appellation for this stratum become imperative. It has therefore been designated Tichenor limestone¹ from its typical exposure in the ravine at Tichenor Point on Canandaigua lake and along the shore toward the south.

It is usually a single compact layer, hard and durable, but at some outcrops the upper or lower part is somewhat shaly, and in the cliff on Smoke's creek near Windom it is separated in two layers, the lower one 15 inches and the upper 9 inches thick.

This stratum emerges from the waters of Lake Erie near the mouth of Pike creek, $5\frac{1}{2}$ miles southwest from the southern limit of this quadrangle on the lake shore, and forms a conspicuous band in the stratigraphy of the south shore at Idlewild and Wanakah cliffs.

At Hamburg-on-the-lake it passes half a mile, and at Athol Springs 200 yards east of the railroad; at Big Tree it is exposed at 640 feet above tide in the railroad cutting near Rush creek and on the banks of the stream near the farmhouse above. At Windom it appears at 680 feet above tide in the banks of Smoke's creek for some distance near the station and crosses the bed of the stream $\frac{1}{8}$ mile further up.

It is also exposed on the east branch of Smoke's creek, 1 mile southwest from Reserve at the top of a cascade 30 feet high, south-east of Reserve along a small brook that empties into Cazenovia creek.

The Tichenor limestone carries an abundant fauna. Dr Grabau's list contains the names of 60 species occurring in this region, of which the following are the more abundant or striking forms:

Phacops rana (<i>Green</i>)	<i>S. mucronotus Hall</i>
Diaphorostoma lineatum (<i>Hall</i>)	<i>Vitulina pustulosa Hall</i>
Modiomorpha concentrica (<i>Conrad</i>)	<i>Centronella impressa Hall</i>
Rhipidomella vanuxemi <i>Hall</i>	<i>Cryptonella planirostra Hall</i>
<i>R. penelope Hall</i>	<i>Tropidoleptus carinatus (Conrad)</i>
<i>Spirifer granulosus (Conrad)</i>	<i>Favosites hamiltoniae Hall</i>

¹N. Y. State Mus. Handbook 19. 1903. p. 22.

Moscow shale

This formation rests on the Tichenor limestone and consists of soft, light bluish gray shales that are usually somewhat calcareous and embrace several courses of concretions. The latter become at some exposures continuous concretionary layers crowded with fossils. In the central part of the State, from Ontario to Chenango counties, the Moscow shale is separated from the black Genesee shale above by the Tully limestone. But both the Genesee shale and the Tully limestone fail to extend to this quadrangle as distinct formations. On Canandaigua lake and westward as far as this quadrangle the Tully horizon is marked only by thin lentils of iron pyrites and the Genesee black shale though 90 feet thick in Ontario county thins out toward the west to so great an extent that it barely reaches the eastern part of this quadrangle, being there but a few inches thick. As a lithologic unit it is absent in the exposures on Smoke's creek and Rush creek and along the lake shore, for no black shales appear between the top of the Moscow shale and the Genundewah limestone. Genesee fossils, however, are found a few inches below the Genundewah limestone in beds of light colored shale and soft limestone, that contain also a small number of Tully and Hamilton species.

Including the 12 to 15 inches of transitional beds at the top just mentioned, the Moscow shales are 17 feet thick at Eighteen Mile creek. Increasing rapidly toward the north and east they measure 52 feet on the south branch of Smoke's creek at Windom, where the entire formation is favorably exposed between the two crossings of the electric railroad over the stream. There are also some slight exposures above the Tichenor limestone along the railroad and Rush creek near Big Tree.

The Moscow shales are everywhere exceedingly rich in fossils, but the specimens are, as a rule, not so well preserved as in the Ludlowville shale, and there is little difference between the faunas of the Moscow and Ludlowville shales. Dr Grabau reports 51 species from the latter in the Eighteen Mile creek region and the following are the common forms:

Phacops rana (<i>Green</i>)	<i>C. mucronatus Hall</i>
Tentaculites gracilistriatus <i>Hall</i>	Leptostrophia perplana (<i>Conrad</i>)
Palaeoneilo tenuistriata <i>Hall</i>	Ambocoelia umbonata (<i>Conrad</i>)
Pholidops hamiltoniae <i>Hall</i>	Atrypa reticularis (<i>Linnè</i>)
Spirifer tullius <i>Hall</i>	<i>A. aspera (Dalman)</i>
<i>S. consobrinus d'Orbigny</i>	Streptelasma rectum <i>Hall</i>
Chonetes deflectus <i>Hall</i>	Cystiphyllum conifolius <i>Hall</i>

Tully horizon

No exposures of the thin lentils of iron pyrites that occur frequently at this horizon from Canandaigua westward to Erie county are found on this quadrangle, but a few species characteristic of the Tully limestone occur in the upper layers of the Moscow shale.

Genesee beds*Genesee black shale*

As noted before the Genesee black shale is absent here with the possible exception of a few inches of black shale near the eastern border; on the south shore cliffs at North Evans, however, it is again represented by 1 foot of characteristic shale.

Genundewah limestone

The Genundewah limestone is a member of the Genesee shale series in west central and western New York. While the Genesee black shale disappears toward the west from the Genesee river, this limestone intercalation persists to the shore of Lake Erie. It is an irregular stratum of concretionary limestone 1 to 2 feet thick, extending across the quadrangle and finely exposed on the south branch of Smoke's creek on the south side of the upper railroad bridge at Windom. It continues beyond the quadrangle toward the southwest to a mile south of the mouth of Pike creek where it dips under the water of the lake and toward the east to the vicinity of Seneca lake, having its highest development at Genundewah point on Canandaigua lake.

Other good exposures besides those at Genundewah point and the ravines toward the north, may be found in the ravine at Bristol Centre and in Mill gull on Honeoye lake in Ontario county; at Eagle point on Conesus lake; on the Genesee river at Mt Morris, Livingston co.; in a small ravine 2 miles north of Wyoming, Wyoming co. and at Griswold station, 6 miles west of Attica.

In the Genesee valley and Canandaigua lake sections the formation has a thickness of 6 to 8 feet and is composed of several thin nodular or compact limestones separated by black shales.

The Genundewah limestone is in many places composed almost entirely of the shells of the minute pteropod *Styliolina fissurella*, and from that fact has been also designated the *Styliola* limestone. But this peculiar pteropod ooze has also furnished an exceedingly interesting fauna of other forms. *Gonia-*

tites, lamellibranchs and gastropods appeared in great numbers and in species characteristic of the later Naples fauna. Dr Clarke has for this reason designated the fauna of the Genundewah limestone as a prenuncial fauna.¹ Among the most interesting members of this fauna are the following:

<i>Dinichthys newberryi Clarke</i>	<i>Bellerophon koeneni Clarke</i>
<i>Spathiocaris emersoni Clarke</i>	<i>B. denckmanni Clarke</i>
<i>Tentaculites gracilistriatus Hall</i>	<i>Macrochilina pygmaea Clarke</i>
<i>Protospiralis minutissima Clarke</i>	<i>M. seneca Clarke</i>
<i>Manticoceras pattersoni var. styliophilum Clarke</i>	<i>Lunulicardium hemicardioides Clarke</i>
<i>M. contractum Clarke</i>	<i>L. encrinurum Clarke</i>
<i>M. fasciculatum Clarke</i>	<i>Honeoyea styliophila Clarke</i>
<i>M. nodiferum Clarke</i>	<i>Pterochaenia fragilis Hall</i>
<i>Gephyroceras genundewa Clarke</i>	<i>P. sinuosa Clarke</i>
<i>Tornoceras uniangulare (Conrad)</i>	<i>Buchiola? livoniae Clarke</i>
<i>Loxonema noe Clarke</i>	<i>B. scabrosa Clarke</i>
<i>Pleurotomaria genundewa Clarke</i>	<i>Paracardium doris Hall</i>
<i>Protocalyptraea styliophila Clarke</i>	<i>P. delicatulum Clarke</i>
<i>Phragmostoma natator Hall</i>	<i>Melocrinus clarkii (Hall) Williams</i>
<i>P. incisum Clarke</i>	<i>Aulopora annectens Clarke</i>

West river shale

Professor Hall separated the Genesee slate in order to indicate its bituminous character by a distinct name. Subsequently the formation here described as West River shale was incorporated into the Genesee shale as upper Genesee shale, but the different lithologic characters of the two, the absence of the bituminous character in the upper shales and the intercalation of a distinct limestone between the two have demonstrated the necessity of subdivision and of separate designations. The term West River shale has been proposed for these lighter shales, overlying the Genundewah limestone [see N. Y. State Mus. Bul. 63. 1904. p. 59].

This formation consists mainly of fine dark gray or bluish black shales, thinly laminated and highly fissile. They are slightly calcareous and become lighter colored on exposure. Layers of bituminous black shale and thin limestone occur in the lower part. Concretions and the septaria known as "turtle stones" are common in these beds farther east and also thin sandy flags occur, though rarely.

The West River shale is 12 feet thick, where exposed on the south branch of Smoke's creek above the upper railroad bridge at Windom.

¹State Geol. An. Rep't 1896. 1899. p. 38; N. Y. State Mus. Mem. 6. 1904. p. 203.

It is 65 feet thick at the mouth of the Genesee river gorge at Mt Morris and 90 feet in Ontario county. There are large exposures of these beds at Mt Morris, on the shores of Conesus and Honeoye lakes, in the Bristol valley, at the head of Canandaigua lake and in the West River valley in Yates county.

Pterochaenia fragilis is abundant in thin layers of this shale at the exposure on Smoke's creek south of Windom. Other fossils are exceedingly rare.

Portage beds

Middlesex black shale

As in the case of the Hamilton beds and other larger divisions it has also become necessary to recognize the distinct component units of the Portage division by separate terms. The Middlesex black shale is the lowest of the subdivisions of the former Portage group. It is abundantly exposed in the Middlesex valley in Yates county, whence the name [see N. Y. State Mus. Mem. 6 and Handbook 19]. It appears as a bed of densely black slaty shale 6 feet thick superjacent to the West River shale at Windom; is found on Eighteen Mile creek and the south shore cliffs and well exposed on Pike creek.

It may be easily distinguished at nearly all of the outcrops from the West River shale by its darker color and more bituminous character. Like all the preceding divisions, it increases slowly in thickness toward the east and is 35 feet thick in Ontario county, where a few thin sandstone slabs and hard blue shales are interstratified at the bottom and near the top.

The Middlesex shale contains very few fossils, but *Lingula ligea* is common in this horizon on Pike creek, North Evans; and it occasionally carries in the central part of the State *Sandbergeroceras syngonum*, *Pterochaenia fragilis* and *Spathiocaris emersoni*, together with plant and fish remains.

Cashaqua shale

The Cashaqua shale is another well characterized subdivision of the Portage beds, for which the original name given by the early geologists has been revived. The type locality of this formation is along Cashaqua creek, a confluent of the Genesee river. The formation is composed of light blue-gray or olive soft shales in which are interbedded at frequent intervals concretionary calcareous layers 2 to 4 inches thick. Layers of dark or black

shale occur, but these are quite rare and very thin, and also rows of spheric or oblong and flattened concretions. Eight feet of the shales at the top of the beds are somewhat darker and harder than those below.

The Cashaqua beds are 32 feet thick in the exposure at the south shore cliffs and in the bed of Pike creek at North Evans. They extend in long flat outcrops in the bed and banks of Smoke's creek, $\frac{1}{2}$ mile south of the upper electric railroad bridge at Windom, and are slightly exposed along the roadside on the hill above the school-house 1 mile south of Big Tree.

The average thickness of the formation on this quadrangle is 45 feet. The thickness increases toward the east and is 165 feet in the Genesee river gorge at Mt Morris and along Cashaqua creek above Sonyea; and at Naples, in Ontario county, it even attains 230 feet.

Nearly all of the northward flowing streams in the eastern part of Erie county and in Wyoming, Livingston and Ontario counties have excavated ravines in the Cashaqua shales, producing large and favorable exposures. Among the best of these are: the ravine of Murder creek at Griswold on the Erie Railroad 6 miles west of Attica; in the Oatka river valley in the vicinity of Wyoming; in the Genesee river gorge between Mt Morris and Smoky Hollow; along Cashaqua creek between Sonyea and Tuscarora; in the ravines along the sides of Conesus and Honeoye lakes and in the southern part of the Bristol valley and in Parrish gully and other ravines at Naples.

Fossils are fairly common in the shales and also in the concretions and they increase in frequency from the lower to the upper beds. The more abundant forms in this vicinity are:

the goniatites

Probeloceras lutheri Clarke

G. cf. domanicense Holzapfel

Gephyroceras holzapfeli Clarke

the lamellibranchs

Lunulicardium pilosum Clarke

Buchiola retrostriata (v. Buch)

Pterochaenia fragilis (Hall)

B. lupina Clarke

P. elmensis Clarke

Paleoneilo petila Clarke

the gastropod

Loxonema noe Clarke

Rhinestreet black shale

This shale consists of a heavy mass of black, bituminous, slaty shale, in which there are a few thin bands of dark bluish, rather

hard shale, usually from 2 to 5 feet thick. The latter contain large symmetric concretions and septaria, some of which attain a diameter of 6 to 8 feet. The formation has a total thickness of about 200 feet on the lake shore in the town of Evans and is 165 feet thick in the southeast corner of this quadrangle. Its lower beds appear along Smoke's creek, $1\frac{1}{2}$ miles south of Windom and some of the shales and concretions near the middle along a branch of the same stream $\frac{1}{2}$ mile west of Orchard Park.

Unlike every other formation represented on this quadrangle except the Bertie waterlime, it becomes thinner toward the east, diminishing at the rate of $1\frac{1}{2}$ feet a mile to Naples, Ontario co., where it measures 21 feet. It may be seen at nearly all of the exposures of the Cashaqua shale at and above cascades produced by its superior resistance to the erosive power of the streams.

Common Portage fossils occur but sparingly in the lighter bands in the western part of the State, and the black shales have been found to contain very few fossils except plant and fish remains and a few conodont teeth.

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New York State Museum

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Museum annual reports 1847-date. *All in print to 1892, 50c a volume, 75c in cloth; 1892-date, 75c, cloth.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904-date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the Museum reports of which they form a part.

Report for 1904, 138p. 20c. Report for 1905 in press.

Geologist's annual reports 1881-date. Rep'ts 1, 3-13, 17-date, O; 2, 14-16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899-1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837-41, are out of print.

Reports 1-4, 1881-84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 30th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	Price	Report	Price	Report	Price
12 (1892)	\$.50	17	\$.75	21	\$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[See Director's annual reports]	

Paleontologist's annual reports 1899-date

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901-3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882-date.

Reports 3-20 bound also with museum reports 40-46, 48-58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4, 17 are out of print, other reports with prices are:

Report	Price	Report	Price	Report	Price
1	\$.50	9	\$.25	15 (En 9)	\$.15
2	.30	10	.35	16 (" 10)	.25
5	.25	11	.25	17 (" 14)	.30
6	.15	12	.25	18 (" 17)	.20
7	.20	13	.10	19 (" 21)	.15
8	.25	14 (En 5)	.20	20 (" 24)	.40
				21	In press

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867-date.

Bound also with museum reports 21-date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports for 1871-74, 1876, 1888-96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [see Bo 5-8].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

NEW YORK STATE EDUCATION DEPARTMENT

Museum bulletins 1887-date. O. To advance subscribers, \$2 a year or \$1 a year for division (1) geology, economic geology, paleontology, mineralogy; 50c each for divisions (2) general zoology, archeology and miscellaneous, (3) botany, (4) entomology.

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	Report	Bulletin	Report	Bulletin	Report	Bulletin	Report
G 1	48, v. 1	Pal 2, 3	54, v. 3	En 11	54, v. 3	Ar 3	52, v. 1
2	51, v. 1	4	v. 4	12, 13	v. 4	4	54, v. 1
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10	v. 3	10	57, v. 1	5	55, v. 1		
11	56, v. 1	En 3	48, v. 1	6	56, v. 4		
M 2	" v. 1	4-6	52, v. 1	7	57, v. 2		
3	57, v. 1	7-9	53, v. 1	Ar 1	50, v. 1		
Pa 1	54, v. 1	10	54, v. 2	2	51, v. 1		

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. 10c.

G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [50c]

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. 5c.

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. 25c.

G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. 10c.

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30c.

G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. 25c.

G8 (84) — Ancient Water Levels of the Champlain and Hudson Valleys. 206p. 11pl. 18 maps. July 1905. 45c.

G9 (95) Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sep. 1905. 30c.

G10 (96) Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30c.

Woodworth, J. B. & Hartnagel, C. A. Miscellaneous Papers. Prepared.

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.

Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.

—The Siluric and Lower Devonian Formations of the Schunemunk Mountain Region.

Fairchild, H. L. Glacial Waters in the Erie Basin. In press.

—Drumlins of New York. In preparation.

Cushing, H. P. Geology of the Theresa Quadrangle. In preparation.

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Berkey, C. P. Geology of the Highlands of the Hudson. In preparation.

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Beauchamp, W. M. Aboriginal Place Names of New York. *Prepared.*
 — Civil, Religious & Mourning Councils and Ceremonies of Adoption.
Prepared.

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Ms2 (66) Ellis, Mary. Index to Publications of the New York State Nat-
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Museum memoirs 1889-date. Q.

1 Beecher, C. E. & Clarke, J. M. Development of Some Silurian Brachi-
 opoda. 96p. 8pl. Oct. 1889. \$1.

2 Hall, James & Clarke, J. M. Paleozoic Reticulate Sponges. 35op. il. 7opl.
 1898. \$1, cloth.

3 Clarke, J. M. The Oriskany Fauna of Becraft Mountain, Columbia Co.
 N. Y. 128p. 9pl. Oct. 1900. 80c.

4 Peck, C. H. N. Y. Edible Fungi, 1895-99. 106p. 25pl. Nov. 1900. 75c.

This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d
 reports of the State Botanist.

5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of
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6 Clarke, J. M. Naples Fauna in Western New York. 268p. 26pl. map.
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7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the
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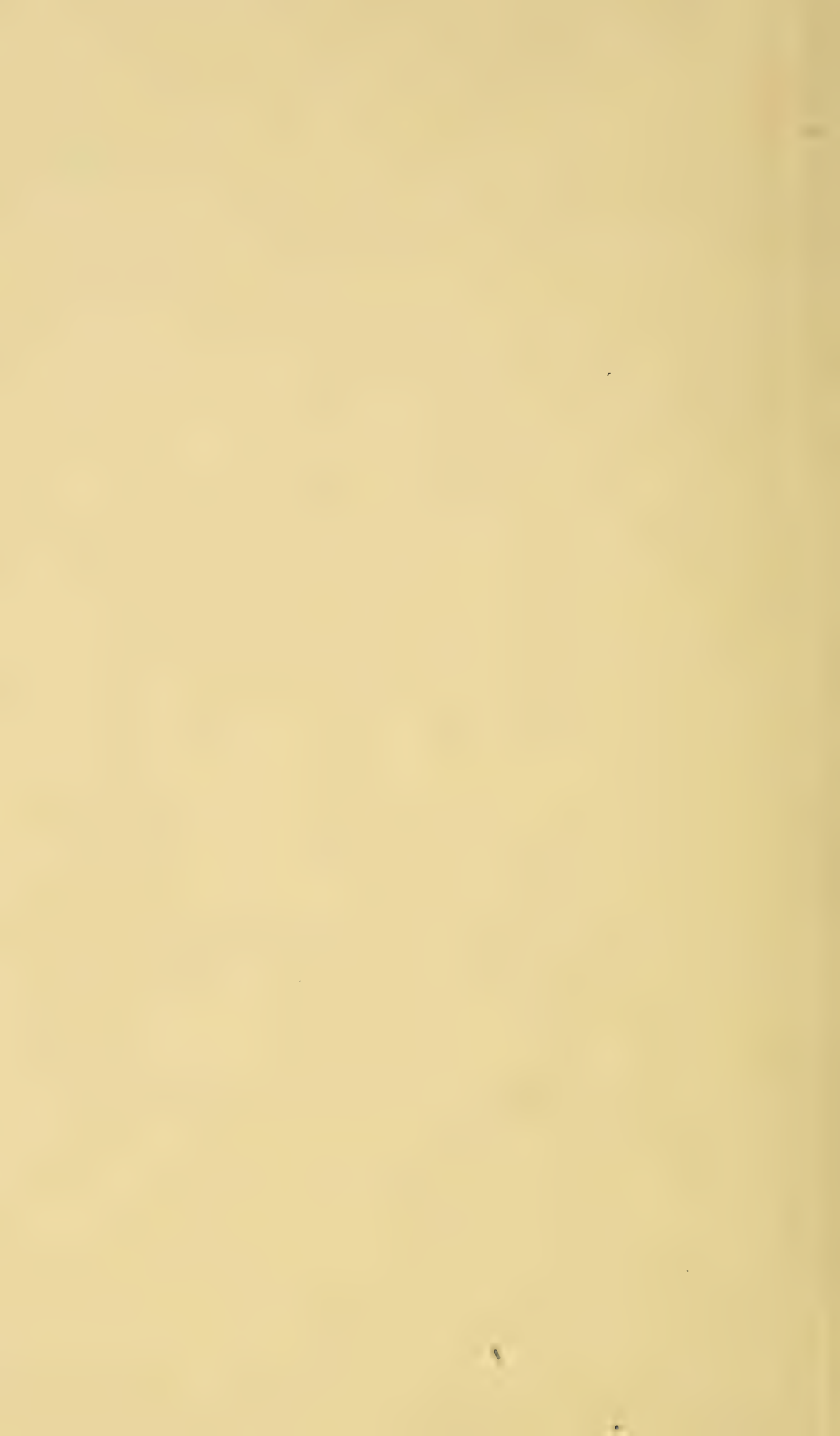
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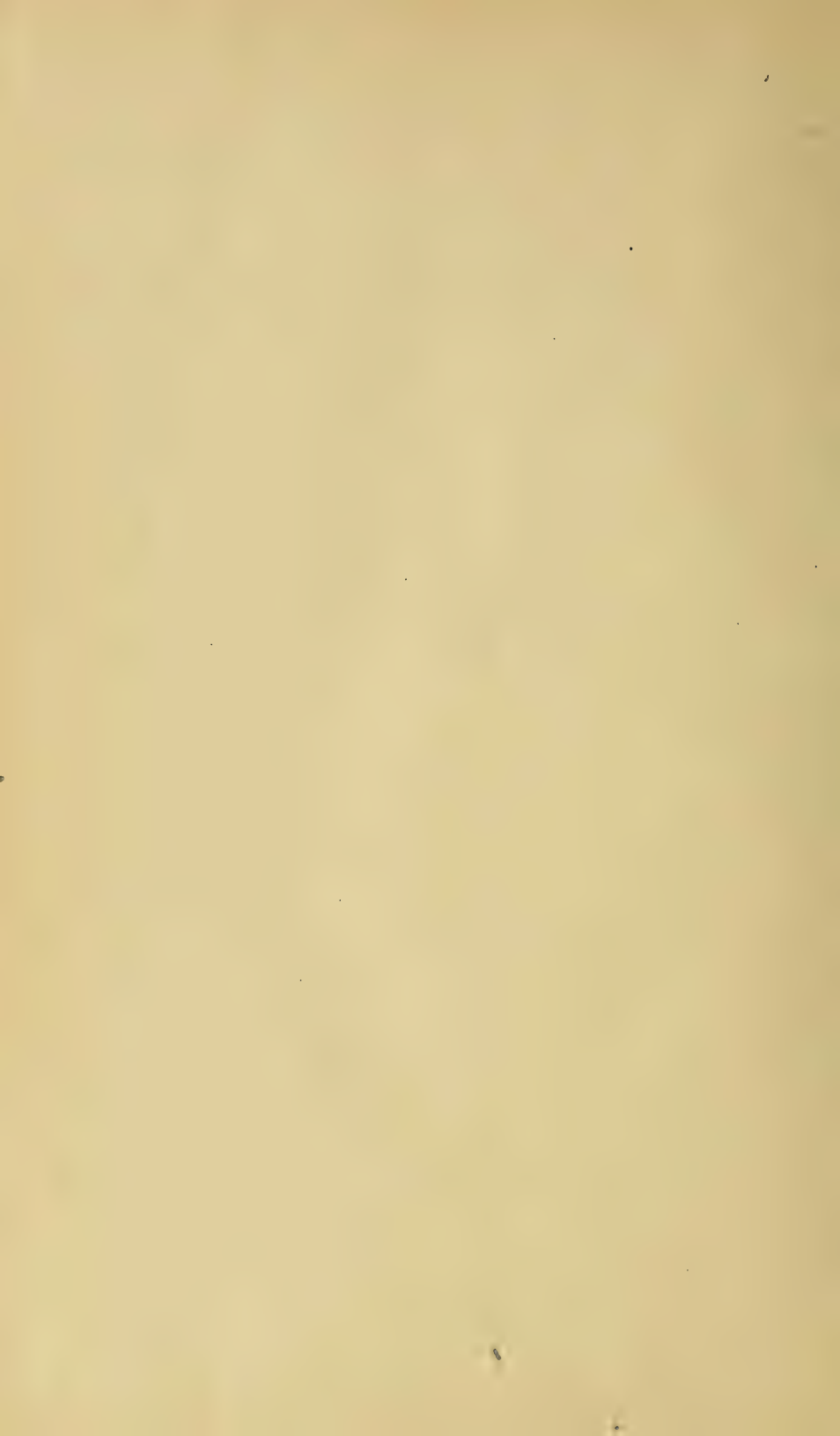
New York State Museum

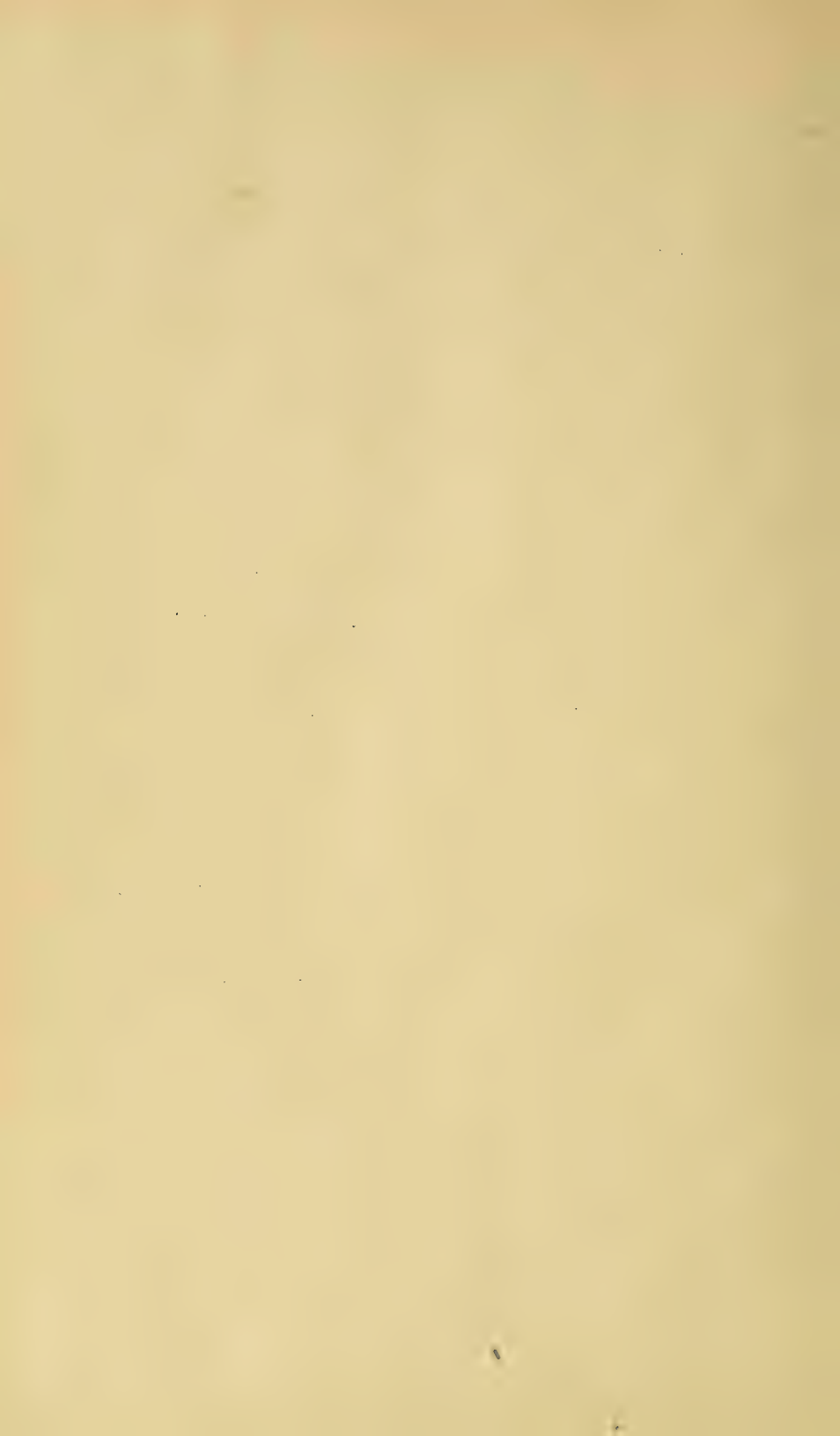
The New York State Museum as at present organized is the outgrowth of the Natural History Survey of the State commenced in 1836. This was established at the expressed wish of the people to have some definite and positive knowledge of the mineral resources and of the vegetable and animal forms of the State. This wish was stated in memorials presented to the Legislature in 1834 by the Albany Institute and in 1835 by the American Institute of New York city and as a result of these and other influences the Legislature of 1835 passed a resolution requesting the Secretary of State to report to that body a plan for "a complete geological survey of the State, which shall furnish a scientific and perfect account of its rocks, soils and materials and of their localities; a list of its mineralogical, botanical and zoological productions and provide for procuring and preserving specimens of the same; etc."

Pursuant to this request, Hon. John A. Dix, then Secretary of State, presented to the Legislature of 1836 a report proposing a plan for a complete geologic, botanical and zoologic survey of the State. This report was adopted by the Legislature then in session and the Governor was authorized to employ competent persons to carry out the plan which was at once put into effect.

The scientific staff of the Natural History Survey of 1836 consisted of John Torrey, Botanist; James E. DeKay, Zoologist; Lewis C. Beck, Mineralogist; W. W. Mather, Ebenezer Emmons, Lardner Vanuxem and Timothy A. Conrad, Geologists. In 1837 Professor Conrad was made Paleontologist and James Hall, who had been an assistant to Professor Emmons, was appointed Geologist to succeed Professor Vanuxem, who took Professor Conrad's place.

The heads of the several departments reported annually to the Governor the results of their investigations, and these constituted the annual octavo reports which were published from 1837 to 1841. The final reports were published in quarto form, beginning at the close of the field work in 1841, and 3000 sets have been distributed, comprising four volumes of geology, one of mineralogy, two of botany, five of zoology, five of agriculture, and eight of paleontology.











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